

## CLAIMS

I/We claim:

- [c1]            1.     A method for removing material from a microelectronic substrate, comprising:
- disposing an electrolytic liquid between an electrically conductive material of a microelectronic substrate and at least one electrode, the electrolytic liquid having about 80% water or less;
- contacting the microelectronic substrate with a polishing pad material;
- electrically coupling the conductive material of the microelectronic substrate to a source of varying electrical signals via the electrolytic liquid and the at least one electrode;
- applying a varying electrical signal to the conductive material;
- moving at least one of the polishing pad material and the microelectronic substrate relative to the other; and
- removing at least a portion of the conductive material from the microelectronic substrate while the electrolytic liquid is adjacent to the electrically conductive material.
- [c2]            2.     The method of claim 1, further comprising forming an oxy-methoxide complex with the electrically conductive material.
- [c3]            3.     The method of claim 1, further comprising oxidizing at least a portion of the conductive material by applying the varying electrical signal to the conductive material.

- [c4]           4.     The method of claim 1 wherein the conductive material includes tantalum and wherein the method further comprises complexing the tantalum as a metal-organic species in solution.
- [c5]           5.     The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 50% water or less.
- [c6]           6.     The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 10% water or less.
- [c7]           7.     The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 1% water or less.
- [c8]           8.     The method of claim 1 wherein disposing an electrolytic liquid includes disposing the electrolytic liquid adjacent to a conductive material that includes tantalum.
- [c9]           9.     The method of claim 1 wherein disposing an electrolytic liquid includes disposing the electrolytic liquid adjacent to a conductive material that includes at least one of tantalum and tantalum nitride.
- [c10]          10.    The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an organic solvent and a salt as constituents.
- [c11]          11.    The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having methanol as a constituent.

[c12] 12. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having ammonium chloride as a constituent.

[c13] 13. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having a non-aqueous polar solvent as a constituent.

[c14] 14. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an organic amine as a constituent.

[c15] 15. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an organic acid as a constituent.

[c16] 16. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having a nitrile as a constituent.

[c17] 17. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an isonitrile as a constituent.

[c18] 18. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an aromatic hydrocarbon as a constituent.

[c19] 19. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an organic phosphate as a constituent.

[c20] 20. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having a halocarbon as a constituent.

- [c21] 21. The method of claim 1 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an alkoxide as a constituent.
- [c22] 22. The method of claim 1, further comprising at least restricting exposure of the electrolytic liquid to water.
- [c23] 23. The method of claim 1, further comprising disposing the microelectronic substrate and the electrolytic liquid in an enclosure, the enclosure at least restricting exposure of the microelectronic substrate and the electrolytic liquid to water.
- [c24] 24. The method of claim 1 wherein the at least one electrode is a first electrode and wherein the method further comprises:  
positioning the first electrode and a second electrode proximate to and spaced apart from the microelectronic substrate;  
disposing the electrolytic liquid in fluid communication with the microelectronic substrate, the first electrode and the second electrode; and  
passing the electrical signal from the first electrode through the electrolytic liquid to the microelectronic substrate and from the microelectronic substrate through the electrolytic liquid to the second electrode.
- [c25] 25. The method of claim 1, further comprising:  
moving at least one of the microelectronic substrate and the polishing pad material relative to the other; and  
controlling a normal force between the microelectronic substrate and the polishing pad material to be about 1.0 psi or less.
- [c26] 26. A method for removing material from a microelectronic substrate, comprising:

disposing an electrolytic liquid between an electrically conductive material of a microelectronic substrate and at least one electrode, the electrically conductive material including at least one of tantalum and a tantalum compound, the electrolytic liquid having about 80% water or less and including a non-aqueous polar solvent;  
electrically coupling the conductive material of the microelectronic substrate to a source of varying electrical signals via the electrolytic liquid and the at least one electrode;  
applying a varying electrical signal to the conductive material;  
moving at least one of the microelectronic substrate and the at least one electrode relative to the other; and  
removing at least a portion of the conductive material from the microelectronic substrate while the electrolytic liquid is adjacent to the electrically conductive material.

[c27] 27. The method of claim 26, further comprising:  
contacting the microelectronic substrate with a polishing pad material; and  
moving at least one of the microelectronic substrate and the polishing pad material relative to the other.

[c28] 28. The method of claim 26, further comprising complexing the tantalum as a metal-organic species in solution.

[c29] 29. The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 50% water or less.

[c30] 30. The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 10% water or less.

- [c31]            31.    The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having about 1% water or less.
- [c32]            32.    The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having an organic solvent and a salt as constituents.
- [c33]            33.    The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having methanol as a constituent.
- [c34]            34.    The method of claim 26 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having ammonium chloride as a constituent.
- [c35]            35.    The method of claim 26, further comprising at least restricting exposure of the electrolytic liquid to water.
- [c36]            36.    The method of claim 26, further comprising disposing the microelectronic substrate and the electrolytic liquid in an enclosure, the enclosure at least restricting exposure of the microelectronic substrate and the electrolytic liquid to water.
- [c37]            37.    The method of claim 26 wherein the at least one electrode is a first electrode and wherein the method further comprises:  
                  positioning the first electrode and a second electrode proximate to and spaced apart from the microelectronic substrate;  
                  disposing the electrolytic liquid in fluid communication with the microelectronic substrate, the first electrode and the second electrode; and

passing the electrical signal from the first electrode through the electrolytic liquid to the microelectronic substrate and from the microelectronic substrate through the electrolytic liquid to the second electrode.

[c38] 38. The method of claim 26, further comprising:  
moving at least one of the microelectronic substrate and the polishing pad material relative to the other; and  
controlling a normal force between the microelectronic substrate and the polishing pad material to be about 1.0 psi or less.

[c39] 39. A method for removing material from a microelectronic substrate, comprising:  
disposing an electrolytic liquid between an electrically conductive material of a microelectronic substrate and at least one electrode;  
electrically coupling the conductive material of the microelectronic substrate to a source of varying electrical signals via the electrolytic liquid and the at least one electrode;  
applying a varying electrical signal to the conductive material;  
at least restricting exposure of the electrolytic liquid to water; and  
removing at least a portion of the conductive material from the microelectronic substrate.

[c40] 40. The method of claim 39 wherein at least restricting exposure of the electrolytic liquid to water includes disposing the microelectronic substrate and the electrolytic liquid in an enclosure, the enclosure being at least partially water tight.

[c41] 41. The method of claim 39 wherein disposing an electrolytic liquid includes disposing an electrolytic liquid having less than about 80% water.

- [c42]            42.    The method of claim 39 wherein at least restricting exposure of the electrolytic liquid to water includes disposing a desiccant at least proximate to the electrolytic liquid.
- [c43]            43.    The method of claim 39 wherein at least restricting exposure of the electrolytic liquid to water includes disposing a desiccant in the electrolytic liquid.
- [c44]            44.    The method of claim 39, further comprising:  
                  contacting the microelectronic substrate with a polishing pad material; and  
                  moving at least one of the microelectronic substrate and the polishing pad material relative to the other.
- [c45]            45.    The method of claim 39 wherein the conductive material includes at least one of tantalum and a tantalum compound, and wherein the method further comprises:  
                  contacting the microelectronic substrate with a polishing pad material;  
                  moving at least one of the microelectronic substrate and the polishing pad material relative to the other;  
                  complexing the conductive material as a metal-organic species in solution;  
                  and  
                  controlling a normal force between the microelectronic substrate and the polishing pad material to be about 1.0 psi or less.
- [c46]            46.    A method for removing material from a microelectronic substrate, comprising:  
                  contacting a microelectronic substrate with a polishing pad material, the microelectronic substrate having a conductive material;  
                  disposing an electrolytic liquid at an interface between the polishing pad material and the microelectronic substrate;  
                  applying a varying electrical current to the conductive material;



moving at least one of the microelectronic substrate and the polishing pad material relative to the other;  
reducing a stability of an oxide of the conductive material by at least restricting exposure of the electrolytic liquid to water;  
removing at least a portion of the conductive material from the microelectronic substrate.

[c47] 47. The method of claim 46 wherein the conductive material includes at least one of tantalum and a tantalum compound, and wherein reducing a stability of an oxide of the conductive material includes reducing a stability of tantalum pentoxide.

[c48] 48. The method of claim 46 wherein at least restricting exposure of the planarizing liquid to water includes disposing the electrolytic liquid and the microelectronic substrate in an enclosure with the enclosure being at least partially water tight.

[c49] 49. A method for removing material from a microelectronic substrate, comprising:  
contacting a microelectronic substrate with a polishing pad material, the microelectronic substrate having a conductive material;  
disposing an electrolytic liquid at an interface between the polishing pad material and the microelectronic substrate;  
applying a varying electrical current to the conductive material via the electrolytic liquid;  
moving at least one of the microelectronic substrate and the polishing pad material relative to the other;  
controlling a normal force between the polishing pad material and the microelectronic substrate by at least restricting exposure of the electrolytic liquid to water; and

removing at least a portion of the conductive material from the microelectronic substrate.

[c50] 50. The method of claim 49 wherein controlling a normal force includes reducing the normal force compared with a normal force required if the exposure of the electrolytic liquid to water were not restricted.

[c51] 51. The method of claim 49 wherein controlling a normal force includes controlling the normal force to be about 1.0 psi or less.

[c52] 52. A method for removing material from a microelectronic substrate, comprising:

contacting a microelectronic substrate with a polishing pad material, the microelectronic substrate having at least one of tantalum and tantalum nitride;

disposing an electrolytic liquid at an interface between the polishing pad material and the microelectronic substrate, the electrolytic liquid having 1% water or less;

at least restricting exposure of the microelectronic substrate, the polishing pad material and the planarizing liquid to water with an enclosure disposed around the microelectronic substrate, the polishing pad and the electrolytic liquid;

positioning first and second electrodes to be spaced apart from the microelectronic substrate and in fluid communication with the microelectronic substrate via the electrolytic liquid;

applying a varying electrical current to at least one of the first and second electrodes;

moving at least one of the microelectronic substrate and the polishing pad material relative to the other;

applying a normal force between the polishing pad material and the microelectronic substrate of about 1.0 psi or less; and removing at least a portion of the conductive material from the microelectronic substrate.

[c53]            53.    The method of claim 52, further comprising forming a tantalum complex.

[c54]            54.    The method of claim 52, further comprising complexing the tantalum as a metal-organic species in solution.

[c55]            55.    The method of claim 52 wherein applying a normal force includes applying a normal force to a microelectronic substrate positioned on top of the polishing pad material.

[c56]            56.    The method of claim 52 wherein moving at least one of the microelectronic substrate and the polishing pad material relative to the other includes moving the microelectronic substrate relative to the polishing pad material.

[c57]            57.    The method of claim 52 wherein disposing a planarizing liquid includes disposing a planarizing liquid containing an electrolyte.

[c58]            58.    An apparatus for removing material from a microelectronic substrate, comprising:  
                  an electrolytic liquid volume coupleable to a supply of electrolytic liquid;  
                  a carrier positioned to releasably carry a microelectronic substrate in fluid communication with the electrolytic liquid volume; and  
                  an enclosure disposed around the electrolytic liquid volume and the carrier, the enclosure being configured to at least restrict passage of water

from a region external of the enclosure to a region internal of the enclosure.

[c59] 59. The apparatus of claim 58 wherein the enclosure is coupled to a source of non-aqueous purge gas.

[c60] 60. The apparatus of claim 58, further comprising a support member configured to carry a polishing pad.

[c61] 61. The apparatus of claim 58, further comprising:  
a support member configured to carry a polishing pad; and  
a polishing pad carried by the support member.

[c62] 62. The apparatus of claim 58, further comprising a support member configured to carry a generally round polishing pad.

[c63] 63. The apparatus of claim 58, further comprising:  
a support member configured to carry an elongated polishing pad;  
a first roller configured to carry an unused portion of the polishing pad; and  
a second roller configured to carry a used portion of the polishing pad.

[c64] 64. The apparatus of claim 58, further comprising:  
a polishing pad; and  
an electrolytic liquid adjacent to the polishing pad, wherein the electrolytic liquid includes an organic solvent.

[c65] 65. The apparatus of claim 58, further comprising:  
a polishing pad; and  
an electrolytic liquid adjacent to the polishing pad, wherein the electrolytic liquid includes about 10% water or less.

- [c66]            66.    An apparatus for removing material from a microelectronic substrate, comprising:
- an electrolytic liquid that includes a non-aqueous polar solvent;
  - a carrier configured to releasably carry a microelectronic substrate in fluid communication with the electrolytic liquid;
  - a polishing pad support; and
  - a polishing pad carried by the polishing pad support, the polishing pad being positioned to contact a microelectronic substrate carried by the carrier.
- [c67]            67.    The apparatus of claim 66 wherein the electrolytic liquid includes about 80% water or less.
- [c68]            68.    The apparatus of claim 66 wherein the electrolytic liquid includes about 1% water or less.
- [c69]            69.    The apparatus of claim 66 wherein the electrolytic liquid includes an organic solvent and a salt.
- [c70]            70.    The apparatus of claim 66 wherein the electrolytic liquid includes methanol.
- [c71]            71.    The apparatus of claim 66 wherein the electrolytic liquid includes ammonium chloride.